SILICA MINERALS IN THE GIBEON IVA IRON METEORITE

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We have studied two slices of the Gibeon IVA iron that contain silica minerals. Previous investigators [1,2] who have reviewed occurrences of silica in IVA irons and related stony-irons have reported tridymite as a very rare component. We have found tridymite in three different types of occurrences, in one of which it is intergrown with quartz, a relationship reflecting a complicated inversion history.

In Slice V (100 x 60 x 3 mm), which contains 2 vugs [3], a 45-µm globule of tridymite embedded in kamacite is partly enclosed by a euhedral crystal of daubréelite ($FeCr_2S_4$) (Fig. 1). The tridymite globule and daubréelite crystal may have grown simultaneously; otherwise the daubréelite is the later phase. In either case, the daubréelite accomodated its form to the presence of the tridymite. Also in this slab, three thin wisps of tridymite, probably crack-fillings, occur within a euhedral crystal of chromite ($FeCr_2O_4$) (Fig. 2). In one instance the tridymite is associated with minute grains of taenite.

In Slice S (60 x 55 x 3 mm) a lath-shaped bronzy tridymite (~3.5 x 0.8 cm) with parallel edges and deeply embayed ends cuts obliquely across the Widmanstätten pattern of the main mass (Fig. 3a). Rather than being a single crystal, the tridymite appears to consist of several domains with different patterns of microfracturing. This tridymite was so large in the 3rd dimension that nine successive slabs were cut from it at the Southwest Meteorite Laboratory. All along the edges of the tridymite, and filling the embayment at each end, are rounded masses of a brassy mineral assemblage [4] reminiscent of those we observed earlier in vugs in the Albion IVA iron and have found again in Gibeon [5,6].

At two sites within the dominant tridymite lath are masses, 3-4 mm across, of milky white to colorless quartz laced with cracks (Fig. 3b). We identified the tridymite and quartz by x-ray diffraction patterns and distinguished the two *in situ* by their characteristic fluorescence under the electron microprobe beam: blue = tridymite, orange = quartz. These fluorescence colors reveal small patches of tridymite amid clumps of quartz fragments (Fig. 3c). This figure also shows an unusual textural pattern in which cores of quartz are partially surrounded by successions of minute, subparallel cracks suggestive of shrinkage cracks in rims around cores. Most of the minute cracks appear to be empty but some are partially filled with metal which could have been injected when the quartz was solid but crackling due to stress from the cooling metal.

In addition to instances of tridymite and quartz occurring side-by-side, we have found minute crystals of each mineral within the other: a 20-µm crystal of quartz within tridymite (Fig. 3d), and a 6-µm crystal of tridymite within quartz (Fig. 3e).

We speculate that while the Widmanstätten pattern was forming as the meteorite cooled through the range of ~550-450°C, tridymite persisted as the dominant metastable polymorph of silica until quartz began to form. The system was quenched before the tridymite-quartz inversion progressed very far. These observations of two intimately associated silica minerals in Gibeon indicate that silica polymorphs are highly sensitive to temperature regimes that may vary sufficiently within distances measured in micrometers to produce an intricate patchwork of phases in different stages of polymorphic transitions.

REFERENCES: [1] Ulff-Moller, F. *et al.*, (1995), *GCA* **59**, 22:4713. [2] Scott, E.R.D., (1996) *GCA* **60**, 9:1615. [3] Petaev, M. I. *et al.*, (*this volume)*. [4] Petaev, M. I. and U.B. Marvin (1997) (*this volume*). [5] Marvin, U. B. *et al.*, (1996), *LPS XXVII* **2**:821. [6] Petaev, M.I. and U. B. Marvin (1996) *Meteorit. Planet. Sci.* Suppl. **31**:A107.

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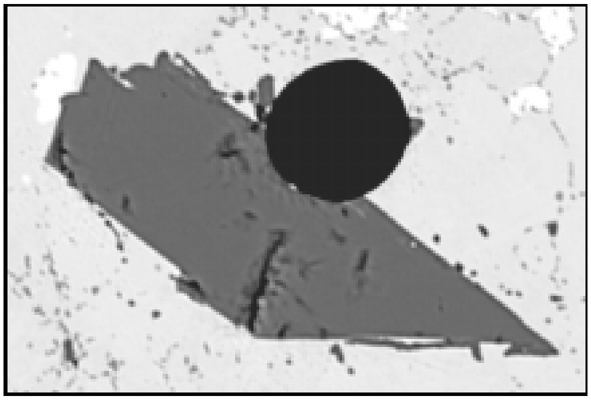

Fig. 1. Tridymite (dark globule) and daubréelite (euhedral gray crystal) embedded in kamacite of the Gibeon iron. (Width of field 170 µm.)

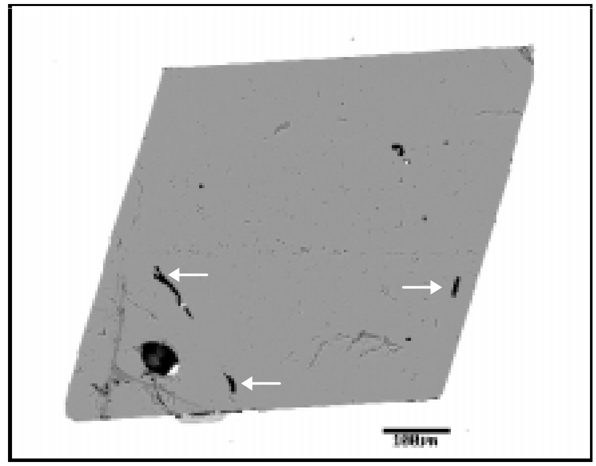

Fig. 2. Euhedral crystal of chromite with three small stringers (crack fillings?) of tridymite (arrows). Two bright grains in tridymite (farthest left) are taenite. (The black oval at lower left is a void.)

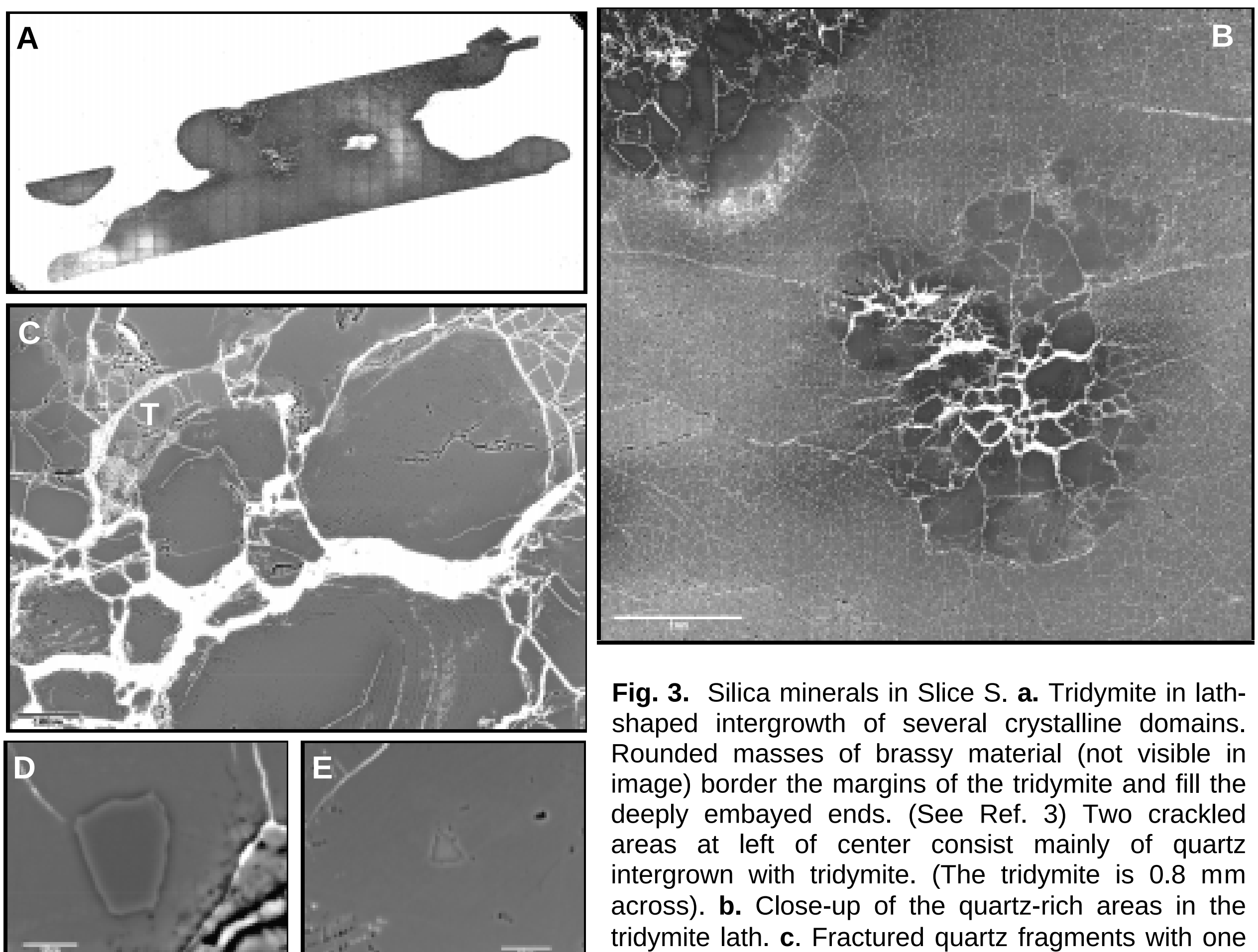

Fig. 3. Silica minerals in Slice S. **a.** Tridymite in lath-shaped intergrowth of several crystalline domains. Rounded masses of brassy material (not visible in image) border the margins of the tridymite and fill the deeply embayed ends. (See Ref. 3) Two crackled areas at left of center consist mainly of quartz intergrown with tridymite. (The tridymite is 0.8 mm across). **b.** Close-up of the quartz-rich areas in the tridymite lath. **c**. Fractured quartz fragments with one patch of tridymite (T). A succession of sub-parallel cracks, some of which have been injected by metal, partially surrounds the largest quartz grain at bottom. **d .** A 20-µm crystal of quartz in tridymite. **e**. A 6-µm crystal of tridymite in quartz.